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## EDUCATION

Ph.D., Organic Chemistry (1980) - University of Grenoble, France  
M.S., Biochemistry (1976) - University of Lyon, France

## SUMMARY

Scientific background includes over 25 years of experience in basic academic and industrial research and vaccinology, encompassing the rationale design, development and testing of a broad bacterial glycoconjugate vaccine platform and diagnostics for human diseases attributable to *Streptococcus agalactiae*, *Neisseria meningitidis*, *Haemophilus influenzae*, *Streptococcus pyogenes*, *Streptococcus pneumoniae*, and *Staphylococcus aureus*. Earlier work (1983- 1991) at the National Research Council of Canada in Ottawa focused on the structure, conformation, immunobiology, and role in pathogenesis of capsular polysaccharides of important human pathogenic bacteria and the development of semi-synthetic vaccines against disease caused by these bacteria. More recent work at Baxter / North American Vaccine (1992 - 2003) has consisted of rationale design, preparation, preclinical studies, and technology transfer for more than a dozen human vaccines which have included all the major serogroups/types for meningococcal, streptococcal, pneumococcal, and Hib polysaccharide conjugates; rPA Anthrax, rOspA Lyme and various combinations. These studies resulted in a licensed product (NeisVac-C™), as well as numerous publications, patents, world-wide regulatory filings, and achievement awards, including the Baxter Distinguished Corporate Contribution Award in 2001 for the development and licensure of its meningococcal C conjugate vaccine, NeisVac-C™ with sales of over \$150 million. Recent management responsibilities as Senior Director of Research for Baxter BioScience-included the following vaccine research departments: Carbohydrate Chemistry, Immunology, Microbiology, Molecular Biology, and Protein Chemistry.

## EXPERIENCE

BAXTER HEALTHCARE CORPORATION, BIOSCIENCE, COLUMBIA, MD: JUNE, 2000 – PRESENT  
NORTH AMERICAN VACCINE, INC. (ACQUIRED BY BAXTER), COLUMBIA, MD: NOVEMBER, 1992 – JUNE, 2000

*Senior Director, Research (December, 2002 – present) – Baxter*

- Responsible for management of 5 vaccine research departments (20 people) including: Carbohydrate Chemistry, Microbiology, Immunology, Molecular Biology, and Protein Chemistry.
- Direct rationale design, preparation, formulation and preclinical studies of polysaccharide conjugates, recombinant, and combination vaccines to cover groups A/B/C/Y/W135 meningococci, groups A & B streptococci, pneumococci, and Hib.
- Direct upstream and downstream technology transfer from Research to Process Development, Clinical Manufacturing, and Quality Control.
- Served as sponsor for meningococcal C/Y/W135 combination conjugate vaccine delivering first Phase I clinical lots.

- Liaison between Research and other functional areas, including Project Management, Process Development, Quality, Regulatory, Clinical, Legal, Finance, Safety, and Human Resources.
- Sponsor for meningococcal conjugate vaccines.
- Recipient of 5 Baxter technical awards, including Baxter Distinguished Corporate Contribution award for development and licensure of meningococcal C conjugate vaccine with sales of over \$150 million.
- Plan and manage departmental program resources.
- Plan research strategies, evaluate new technologies, and set up outside collaborations.

***Director, Research / Senior Director, Carbohydrate Chemistry (June, 2000 – December, 2002) – Baxter***  
***Senior Director, Carbohydrate Chemistry (November, 1992 – June, 2000) – NAVA***

- Responsible for management of the Carbohydrate Chemistry research department (11 people).
- Worked through due diligence conducted on NAVA, providing numerous vaccine presentations leading to \$400 million acquisition by Baxter.
- Directed preparation, formulation and preclinical studies on conjugate and combination vaccines to cover meningococci, groups A & B streptococci, pneumococci, and Hib.
- Served as sponsor for meningococcal B, Hib, and streptococcal B conjugate vaccines delivering first Phase I clinical lots.
- Planned and managed departmental program resources.
- Planned research strategies, evaluate new technologies, and set up outside collaborations.

***Director, Carbohydrate Chemistry (November, 1992 – August, 1999) - NAVA***

- Responsible for management of the Carbohydrate Chemistry department (11 people).
- Directed conceptual design, preparation, formulation and preclinical studies on conjugate and combination vaccines to cover meningococci, groups A & B streptococci, pneumococci, and Hib.
- Member of joint management team, and liaison in NAVA/Pasteur Mérieux Connaught partnership on meningococcal B conjugate vaccine.
- Planned and managed departmental program resources.
- Planned research strategies, evaluate new technologies, and set up outside collaborations.

***Senior Scientist and Group Leader (September, 1987 - November, 1992) – Biochem Pharma***

- Initiated Development of Conjugate technology platform at the NRC in Ottawa, Canada.
- Rationale design of meningococcal C conjugate vaccine (NeisVac-C), streptococcal B and pneumococcal conjugates.
- Established basic IP portfolio of patents.
- Conjugate Technology transfer to NAVA.

## **AWARDS**

**Award from the National Research Council of Canada (2001)** for the Generation of Substantial Royalties for the Meningococcal C Vaccine

**Baxter Distinguished Corporate Contribution (2001):** De-O-Acetylated Protective Epitope on the MenC Polysaccharide – A Novel Conjugate Vaccine against Meningococcal C Meningitis.

**Baxter Outstanding Innovation (2001):** Development of Novel Carrier Proteins / Group B Meningococcal Vaccine Conjugate Vaccine.

**Baxter Outstanding Innovation (2001):** Novel Semi-Synthetic Polysaccharide-Protein Conjugate Vaccines.

**Baxter Special Accomplishment (2001):** Development of a Novel *Haemophilus Influenzae* Polysaccharide Conjugate Vaccine.

**Baxter Special Accomplishment (2001):** Polysaccharide Purification Technology Platform.

## **PATENTS**

- US5,225,331** Immunoassay for detecting group B streptococcus (1993)
- US5,425,946** Vaccines against group C Neisseria meningitidis (1995)
- US5,576,002** Meningococcal polysaccharide conjugate vaccine (1996)
- US5,683,699** Meningococcal polysaccharide conjugate vaccine (1997)
- US5,773,007** Vaccine compositions (1998)
- US5,811,102** Modified meningococcal polysaccharide conjugate vaccine (1998)
- US5,866,135** Group A streptococcal polysaccharide conjugate vaccine (1999)
- US5,902,586** Meningococcal polysaccharide conjugate vaccine (1999)
- US5,969,130** Meningococcal polysaccharide conjugate vaccine (1999)
- US6,248,570** Procedure for the extraction and isolation of bacterial capsular polysaccharides for use as vaccines or linked to protein as conjugate vaccines (2001)
- US6,267,961** Direct methods for molar-mass determination of fragments of Haemophilus influenzae type b capsular polysaccharides and vaccine preparations (2001)
- US6,284,884** Antigenic group B streptococcus type II and III polysaccharide fragments having a 2,5-anhydro-D-mannose terminal structure and conjugate vaccine thereof (2001)
- US6,350,449** Antibodies to meningococcal polysaccharide conjugate vaccines (2002)
- US6,372,222** Antigenic group B streptococcus type II and III polysaccharide fragments having a 2,5-anhydro-D-mannose terminal structure and conjugate vaccine thereof (2002)
- US6,451,317** Immunogenic conjugates comprising a Group B meningococcal porin and an Haemophilus influenzae polysaccharide (2002)
- US6,596,283** Meningococcal polysaccharide conjugate vaccines (2003).
- US6,602,508** Method of Immunization using a Group B Streptococcus type II and Type III polysaccharide conjugate vaccine

## **World PCT Publications**

- WO9108772A1** Improved meningococcal polysaccharide conjugate vaccine (1991)

**WO9204915A1** Improved vaccine compositions (1992)

**WO9219969A1** Immunoassay for detecting group B streptococcus (1992)

**WO9528960A1** Group A streptococcal polysaccharide immunogenic compositions and methods (1995)

**WO9640239A1** Modified meningococcal polysaccharide conjugate vaccines (1996)

**WO9640795A1** Antigenic group B streptococcus type II and III polysaccharide fragments having a 2,5-anhydro-D-mannose terminal structure and conjugate vaccine thereof (1996)

**WO9728273A1** Expression of Group B Neisseria meningitidis outer membrane (MB3) protein from yeast and vaccines

**WO9822490A1** Direct methods for molar-mass determination of fragments of Haemophilus influenzae type b capsular polysaccharides vaccine preparations (1998)

**WO9903501A1** Immunogenic conjugates comprising a Group B meningococcal porin and an Haemophilus influenzae polysaccharide (1999)

**WO9903884A2** Modified immunogenic pneumolysin compositions as vaccines (1999)

**WO9932653A1** Procedure for the extraction and isolation of bacterial capsular polysaccharides for use as vaccines or linked to proteins as conjugate vaccines (1999)

**WO0010599A2** Immunogenic  $\beta$ -Propionamido-linked polysaccharide protein conjugate useful as a vaccine produced using an N-acryloylated polysaccharide (2000)

**WO02092131A2** Immunogenic compositions of low molecular weight hyaluronic acid and methods to prevent, treat and diagnose infections and diseases caused by group A and C streptococci (2002)

**WO02092131A3** Immunogenic conjugates of low molecular weight hyaluronic acid with polypeptide toxins (2002)

#### **PROVISIONAL PATENT APPLICATIONS**

**No. 20695/0014** Chimeric multivalent polysaccharide conjugate vaccines (filed July 30, 2002)

**No. 38777/0050** Carriers proteins for vaccines (filed June 23, 2003)

**No. 38777/0055** Meningococcal Y conjugate vaccines and combinations thereof (filed June 23, 2003)

## PUBLICATIONS IN PEER REVIEW JOURNALS WITH INTERNATIONAL CIRCULATION

1. JOSELEAU, J.P., Michon, F. and Vignon, M. Structural investigations on the capsular polysaccharide from *Klebsiella* serotype K-34 and its characterization by NMR spectroscopy. **CARBOHYDRATE RESEARCH** 101, 175-185, 1982.
2. Banoub, J.H. and Michon, F. Chromium trioxide oxidation of acetylated 3-amino-3,6-dideoxy-L-hexosides. **CANADIAN JOURNAL OF BIOCHEMISTRY** 60, 517-520, 1982.
3. Banoub, J.H. and Michon, F. A rapid GLC-MS method for identification of the N-acetyl group of amino sugars in complex carbohydrates. **CARBOHYDRATE RESEARCH** 100, C24-C26, 1982.
4. Vignon, M., Michon, F., Joseleau, J.P. and Bock, K. Molecular motion of branched chain polysaccharides studied by  $^{13}\text{C}$ -NMR spin-lattice relaxation rates. **MACROMOLECULES** 16, 835-838, 1983.
5. Banoub, J.H., Michon, F. Rice, J. and Rateb, L. Kinetic studies on the rearrangement of 3,4-di-O-benzyl-1,2-O-(1-methoxy-ethylidene)-L-rhamnopyranoside with a catalytic amount of 1,1,3,3-tetramethylurea-trifluoromethane sulfonic acid at different temperatures. **CARBOHYDRATE RESEARCH** 123, 109-116, 1983.
6. Banoub, J.H., Choy, Y.M., Michon, F. and Shaw, D.H. Structural investigation on the core oligosaccharide of *Aeromonas hydrophila* Chemotype II. **CARBOHYDRATE RESEARCH** 114, 267-276, 1983.
7. Banoub, J.H., Shaw, D.H. and Michon, F. Hydrolytic release and identification by Glc-MS of 3-deoxy-D-manno-2-octulosonic acid in the lipopolysaccharides isolated from bacteria of the Vibrionaceae. **CARBOHYDRATE RESEARCH** 123, 117-122, 1983.
8. Banoub, J.H., Michon, F., Shaw, D.H. and Roy, R. EI and CI mass spectral identification of some derivatives of 7-O-[2-amino-2-deoxy-D-glucopyranosyl]-L-glycero-D-mannoheptose, obtained from lipopolysaccharides representative of the *Vibrionaceae* family. **CARBOHYDRATE RESEARCH** 128, 203-216, 1984.
9. Michon, F., Roy, R., Jennings, H.J. and Ashton, F.E. Structural elucidation of the capsular polysaccharide of *Neisseria meningitidis* Group H. **CANADIAN JOURNAL OF CHEMISTRY** 62, 1519-1524, 1984.
10. Michon, F., Shaw, D.L. and Banoub, J.H. Structure of the lipopolysaccharide core isolated from a human strain of *Aeromonas hydrophila*. **EUROPEAN JOURNAL OF BIOCHEMISTRY** 145, 107-114, 1984.
11. Jennings, H.J., Katzenellenbogen, E., Lugowski, C., Michon, F., Roy, R. and Kasper, D.L. Structure, conformation and immunology of sialic acid-containing polysaccharides of human pathogenic bacteria. **PURE AND APPLIED CHEMISTRY** 56, 893-905, 1984.
12. Banoub, J.H., Michon, F. and Shaw, D.H. Formation of 1,6-anhydro-3,4-di-O-acetyl-2,7-di-O-methyl-L-glycero-D-manno-heptopyranose during methylation analysis of lipopolysaccharide-cores representative of the *Vibrionaceae* family. **CARBOHYDRATE RESEARCH** 138, 171-175, 1985.

13. Jennings, H.J., Roy, R. and Michon, F. Determinant specificities of the Groups B and C of *Neisseria meningitidis* polysaccharides. **JOURNAL OF IMMUNOLOGY** 134, 2651-2657, 1985.
14. Jennings, H.J., Roy, R. and Michon, F. Conformational determinant critical to the immunospecificity of the Group B *Neisseria meningitidis* polysaccharide. **FEDERATION PROCEEDINGS** 44, 779, 1985.
15. Banoub, J.H., Michon, F., Roy, R., Grouiller, A. and Bazin, H. EI and CI mass spectroscopy of peracetylated methyl glycosides and alditols of 2-amino-2,4-dideoxy-DL- and 3-amino-3,4-dideoxy-DL-pentopyranoses. **CARBOHYDRATE RESEARCH** 144, 127-136, 1985.
16. Michon, F., Brisson, J-R., Roy, R., Ashton, F.E. and Jennings, H.J. Structure of the capsular polysaccharide of *Neisseria meningitidis* Group I. A 2D-NMR analysis. **BIOCHEMISTRY** 24, 5592-5598, 1985.
17. Michon, F., Brisson, J-R., Roy, R., Ashton, F.E. and Jennings, H.J. Structure of the capsular polysaccharide of *Neisseria meningitidis* Group K. A 2D-NMR analysis. **CANADIAN JOURNAL OF CHEMISTRY** 63, 2781-2786, 1985.
18. Banoub, J.H., Michon, F. and Cooper, F. Occurrence of 3-acetamido-3,6-dideoxy-4-O-methyl-L-glucose in the O-polysaccharide of *Vibrio anguillarum*. **CANADIAN JOURNAL OF BIOCHEMISTRY AND CELL BIOLOGY** 63, 1265-1267, 1985.
19. Banoub, J.H., Michon, F. and Hodder, H.J. Structural elucidation of the O-specific polysaccharide of the phenol-phase soluble lipopolysaccharide of *Vibrio anguillarum*. **CANADIAN JOURNAL OF BIOCHEMISTRY AND CELL BIOLOGY** 65, 19-26, 1986.
20. Michon, F., Katzenellenbogen, E., Jennings, H.J. and Kasper, D.L. Structure of the complex group specific polysaccharide of *Group B Streptococcus*. **BIOCHEMISTRY** 26, 476-486, 1987.
21. Lee, J.C., Michon, F., Perez, N.E., Hopkins, C.A. and Pier, G.B. Chemical characterization and immunogenicity of capsular polysaccharide isolated from mucoid *Staphylococcus aureus*. **INFECTION AND IMMUNITY** 55, 2191-2197, 1987.
22. Michon, F., Brisson, J-R. and Jennings, H.J. Conformational differences between linear -(2,8)-linked homosialo-oligosaccharides and the epitope of the Group B meningococcal polysaccharide. **BIOCHEMISTRY** 26, 8399-8045, 1987.
23. Jennings, H.J., Gamian, A., Michon, F., Roy, R. and Ashton, F.E. A chemically modified Group B meningococcal polysaccharide. In *Towards Better Carbohydrate Vaccine* (Bell, R. and Torrigiani, G. eds). John Wiley and Sons Ltd. pp. 11-22, 1987.
24. Jennings, H.J., Ashton, F.E., Gamian, A. Michon, F. and Roy, R. Chemically modified Group B meningococcal polysaccharides as human vaccine. In *Industrial Polysaccharides: Genetic Engineering, Structure/Property Relations and Applications* (Yalpani, M., ed.) pp. 149-156, 1987.
25. Jennings, H.J., Beurret, M., Gamian, A. and Michon, F. Structure and immunochemistry of meningococcal lipopolysaccharides. **ANTONIE VAN LEEUWENHEK JOURNAL OF MICROBIOLOGY** 53, 519-522, 1987.

26. Jennings, H.J., Beurret, M., Gamian, A. and Michon, F. Structure and immunochemistry of meningococcal lipopolysaccharides. *In* Gonococci and Meningococci (Poolman, J.T. et al. eds.), Academic Press, The Netherlands, pp. 553-556, 1988.
27. Michon, F., Brisson, J.-R., Dell, A., Kasper, D.L. and Jennings, H.J. The multiantennary group-specific polysaccharide of *Group B Streptococcus*. **BIOCHEMISTRY** 27, 5341-5351, 1988.
28. Kabat, E.A., Liao, J., Osserman, E.F., Gamian, A., Michon, F. and Jennings, H.J. The epitope associated with the binding of the capsular polysaccharide of the *Group B meningococcus* and of *Escherichia coli* K1 to a human monoclonal macroglobulin, IgM<sup>NOV</sup>. **JOURNAL OF EXPERIMENTAL MEDICINE** 168, 699-711, 1989.
29. Wessels, M.R., Benedi, V.-J., Jennings, H.J., Michon, F., DiFabio, J.L. and Kasper, D.L. Isolation and characterization of the type IV *Group B Streptococcus* capsular polysaccharide. **INFECTION AND IMMUNITY** 57, 1089-1094, 1989.
30. Jennings, H.J., Gamian, A., Michon, F. and Ashton, F.E. Unique intermolecular bactericidal epitope involving the homosialopolysaccharide capsule on the cell surface of *Group B Neisseria meningitidis* and *Escherichia coli* K1. **JOURNAL OF IMMUNOLOGY** 142(10), 3585-3591, 1989.
31. DiFabio, J.L., Michon, F., Brisson, J.-R., Benedi, V.-J., Wessels, M.R., Kasper, D.L. and Jennings, H.J. Structure of the capsular polysaccharide antigen of type IV *Group B Streptococcus*. **CANADIAN JOURNAL OF CHEMISTRY** 67, 877-882, 1989.
32. DiFabio, J.L., Michon, F., Brisson, J.-R., Benedi, V.-J., Wessels, M.R., Kasper, D.L. and Jennings, H.J. Structural determination and immunochemical characterization of the type V *Group B Streptococcus* capsular polysaccharide. **JOURNAL OF BIOLOGICAL CHEMISTRY** 266, 6714-6719, 1991.
33. Michon, F., Pozsgay, V., Brisson, J.-R. and Jennings, H.J. Substrate specificity of naringinase, an -L-rhamnosidase from *Penicillium decumbens*. **CARBOHYDRATE RESEARCH** 194, 321-324, 1989.
34. Ashton, F.E., Michon, F., Ryan, T.A. and Jennings, H.J. Protective efficacy of mouse antiserum to the N-propionylated derivative of the meningococcal *Group B* polysaccharide. **MICROBIAL PATHOGENESIS** 6, 455-458, 1989.
35. Dell, A., Azadi, P., Tiller, P.R., Thomas-Pates, J.E., Jennings, H.J., Beurret, M. and Michon, F. Analysis of oligosaccharide epitopes of meningococcal lipopolysaccharide by fast atom bombardment mass spectroscopy. **CARBOHYDRATE RESEARCH** 200, 59-76, 1990.
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37. DiFabio, J.L., Michon, F., Brisson, J.-R. and Jennings, H.J. Structure of the L1 and L6 core oligosaccharide epitopes of *Neisseria meningitidis*. **CANADIAN JOURNAL OF CHEMISTRY** 68, 1029-1034, 1990.

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39. Wessels, M.R., Paoletti, L.C., Kasper, D.L., DiFabio, J.L., Michon, F., Holme, K. and Jennings, H.J. Immunogenicity in animals of a polysaccharide-protein conjugate vaccine against type III Group B *Streptococcus*. **JOURNAL OF CLINICAL INVESTIGATION** 86, 1428-1433, 1990.
40. Tzianabos, A., Pantosti, A., Baumann, H., Michon, F., Brisson, J.-R., Jennings, H.J., and Kasper, D.L. Characterization of two surface polysaccharides of *Bacteroides Fragilis*. **TRANS ASSOC AM PHISICIANS** 104, 285-295, 1991.
41. Michon, F., Chalifour, R., Feldman, R., Wessels, M., Kasper, D.L., Gamian, A., Pozsgay, V. and Jennings, H.J. The -L-(1-2)-Trirhamnopyranoside epitope in the group specific polysaccharide of Group B *Streptococcus*. **INFECTION AND IMMUNITY** 59, 1690-1696, 1990.
42. Ashton, F.E., Michon, F., Bundle, D., Gidney, M., Gamian, A. and Jennings, H.J. Immunological properties of monoclonal antibodies to the N-propionyl derivative of Group B meningococcal polysaccharide (Achtman, M., Kohl, P., Marchal, C., Morelli, G., Seiler, A., Thiesen, B., eds.), *Neisseria* 1990. **PROCEEDINGS OF THE SEVENTH INTERNATIONAL PATHOGENIC NEISSERIA CONFERENCE**, Berlin, Germany, September 9-14, 1990. Walter de Gruyter, pp. 187-191, 1991.
43. Baumann, H., Brisson, J.-R., Michon, F. and Jennings, H.J. N.M.R. and conformational analysis of derivatives of -2,8-Sialyl oligosaccharides and comparison with the native compounds. **GLYCOCONJUGATE JOURNAL** 8, 126-127, 1991.
44. Bauman, H., Brisson, J.-R., Michon, F., Jennings, H.J., Tzianabos, A.O., and Kasper, D.L. Structural studies of two surface polysaccharides from the capsule of *Bacteroides fragilis* NCTC 9343. **GLYCOCONJUGATE JOURNAL** 8, 245-246, 1991.
45. Paoletti, L.C., Kasper, D.L., Michon, F., DiFabio, J., Jennings, H.J., Toaleson, T.D. and Wessels, M.R. Effects of chain length on the immunogenicity in rabbits of Group B *Streptococcus* type III oligosaccharide-tetanus toxoid conjugates. **JOURNAL OF CLINICAL INVESTIGATION** 83, 203-209, 1992.
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52. Brisson, J.-R., Baumann, H., Michon, F., Pon, R. and Jennings, H.J. Comparison of the conformations of the (2,8)-linked sialic acid meningococcal polysaccharide with its reduced and N-acyl derivatives. **BIOCHEMISTRY** 32, 4000-4013, 1993.
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## ABSTRACTS / ORAL PRESENTATIONS (NAVA/BAXTER 1992-2003)

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